

moving from latitude  $\phi$  to latitude  $\phi_1$ . Easterly velocity signifies the easterly component of the relative velocity of the body. The relative velocity is the initial velocity of projection, irrespective of direction. If the body is projected due north, its easterly velocity is zero at the point of projection which is *A* in the figure. As it curves to the eastward the easterly component of the relative velocity gradually increases until when it reaches *C* its easterly velocity equals its relative velocity. In the above illustration, the body moving from latitude  $50^\circ$  to  $50^\circ 24'$  acquires an easterly velocity in accordance with the law of preservation of areas of 5 meters per second in excess of that which it possessed at latitude  $50^\circ$ . The easterly velocity at *A* was zero. Hence at latitude  $50^\circ 24'$  it has acquired an increased easterly velocity of 5 meters per second but its relative velocity is unchanged. Continuing to move southward, it loses its easterly velocity at *D* and gains a westerly velocity of 5 meters per second at *E*, the most southerly point reached.

Therefore a body moving freely under the influence of the earth's deflective force undergoes variations in its easterly velocity in strict accordance with the principle of the preservation of areas. Its relative velocity or initial velocity of projection remains unchanged. The deflective force acts perpendicularly to the momentary direction of motion, causing the body to describe a nearly circular path with unchanged initial relative velocity. A body moving freely over the earth's surface from one latitude to another can and does obey the law of equal areas without any change in its relative velocity. At the extreme latitude which it is able to reach in its curved path it gains or loses by the law of areas an easterly velocity precisely equivalent to its initial velocity, if the direction of projection is along a meridian.

In the above quotation from Davis the term velocity is used in one sense only, meaning relative velocity. Referring to Hadley's teaching that a body moving toward the Equator continually lags westward and would attain a great velocity to the west when it reached the Equator, he makes the criticism that this lagging can produce no effect on the velocity, meaning relative velocity. Hadley was correct in the sense that a change of latitude involves a change in the easterly velocity of a freely moving body, but he was wrong in assuming that a change in relative velocity would result. In

Davis's illustration a body given a velocity of 25 miles per hour to the southward at latitude  $30^\circ$  would not even reach latitude  $28^\circ$ , a fact which he omitted to state. In order that it may reach the equator it should have an initial southward velocity of 116 meters per second, and at the Equator it would be moving due westward with its initial velocity.

Thus moving air does not acquire the excessive velocities implied in the extracts given above, because it does not move over the required range of latitude. The increase in easterly velocity is checked when the limiting latitude is reached, hence friction is obviously not needed to reduce the excessive velocities.

In order that the body may continue in its original direction of projection, a force equal and opposite to the deflective force must act on the body. Assume that the body moves on a plane with an inclination to the left of the direction of projection. With the direction due north, the plane will slope to the west. If the inclination of the plane is such that the small component of gravity tending to draw the body down the plane is equal to the deflective force, the inclination of the plane gradually increasing with increasing latitude, the body will continue moving in a due north direction with uniform velocity.

The uniform motion of a body on an inclined plane is strictly analogous to that of air particles along straight isobars, neglecting friction. Consider isobars extending north and south with low pressure to westward and high pressure to eastward. The air particles will have a movement from south to north with uniform velocity under the equal and opposite influences of the gradient tending to force the particles to the westward and the earth's deflective force tending to swerve them eastward. It is obvious that allowing for an increase in gradient with increasing latitude, the condition of steady motion is realized and the air particles move over a wide range of latitude with uniform velocity. The principle of the preservation of areas is not thereby invalidated nor is it necessary to assume that retarding or damping influences operate to reduce the increased velocities called for by the change of latitude. The increase of relative easterly velocity due to increase of latitude is exactly neutralized by the increase of westerly velocity due to the gradient.

## NOTES, ABSTRACTS, AND REVIEWS.

### METEOROLOGICAL INFLUENCES OF THE SUN AND THE ATLANTIC.<sup>1</sup>

By Prof. J. W. GREGORY, F. R. S.

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The prospects of long-period weather forecasting and the explanation of major variations of climate appear to rest on two lines of investigation. The effort of the first is to connect changes in the weather with those in oceanic circulation; the second attributes the changes to variations in the heat supply of the sun acting through the atmospheric circulation. Each theory has its own *a priori* probability. The oceanic control of climate has the attraction that each ocean is a potential refrigerator, since it is a reservoir of almost ice-cold water, which, if

raised to the surface, must chill the air, disturb the winds, and enable polar ice to drift further into the temperate seas. Hence Meinardus, for example, connected the range of ice in the Icelandic seas and harvests in Germany with variations in the surface waters of the North Atlantic. The alternative theory has the recommendation that, since the earth receives its heat supply from the sun, variation in solar activity is the natural cause of climatic change.

The oceanic theory must be true in part. The abnormal character of some coastal climates is clearly due to the upwelling of cold water under the influence of off-shore winds. Moreover, unusual spells of weather on some of the coasts and islands of the Atlantic follow changes in the quality of its surface water, as proved by Dr. H. N. Dickson for Northwestern Europe, and by Prof. H. H. Hildebrandsson's demonstration that for 15 years there has been constant coincidence between rainfall in British Columbia and the weather in the following autumn in the Azores. The alternative theory that the

<sup>1</sup> Björn Helland-Hansen and Fridtjof Nansen, "Temperature Variations in the North Atlantic Ocean and in the Atmosphere." Introductory Studies on the Cause of Climatological Variations. Smithsonian Miscellaneous Collections, vol. lxx., Publication 2537, 1920. Pp. viii+408+48 plates.

Author's abstract of original work in German, published in MONTHLY WEATHER REVIEW, April, 1918, 46: 177-178.

main factor in controlling the temperature of the earth is the varying heat from the sun acting through changes of wind and atmospheric pressure has been mainly advanced by the work of Sir Norman and Dr. W. J. S. Lockyer and of Prof. Frank Bigelow; they are now strongly reinforced by Dr. B. Helland-Hansen, the director of the biological station at Bergen, and Dr. Nansen, who remark that these views have hitherto received but little support.

The important memoir by these Norwegian oceanographers is based on a detailed study of variations in the temperatures of the air and surface waters along the steamer route from the English Channel to New York. Their detailed discussion of the results and associated problems is accompanied by a valuable series of temperature charts of the North Atlantic for the months of February and March from 1898 to 1910. The data are often uncertain, and the inconvenience of the centigrade thermometer with its zero at freezing point is illustrated by records of water temperature of  $-3^{\circ}\text{C}$ . and  $-4^{\circ}\text{C}$ ., which have to be rejected. Drs. Helland-Hansen and Nansen, after discussion of the theory of oceanic control, reject it as quite inadequate. Thus the chilling effect of the drift of ice into the North Atlantic they estimate as "vanishingly small" in comparison with the heat transported by the air, or even by ocean currents. They consider that, though not yet fully established, the variations of the air temperature preceded, and were therefore not the result of, those of the water temperature. They hold that the variations of temperature require some much greater and more general cause than oceanic variations.

Faith in the meteorological influence of oceanic circulation was greatly favored by the exaggerated estimates attached to what the authors refer to as "the so-called Gulf Stream." Thus the warmth of the water off the Norwegian coast was attributed to that current even by Pettersson and Meinardus; this conclusion the authors describe as surprising because the evidence of salinity shows that the Norwegian waters are coastal and quite different from those of the mid-Atlantic. This sound criticism of the Swedish and Münster oceanographers renders it the more remarkable that there is no reference, either in the long historical discussion or in the bibliography, to the pioneer work on this subject in the earlier papers by Dr. H. N. Dickson, or to his observations as to the seasonal entrance of the Atlantic water into the North Sea. The authors agree with Schott in terminating the Gulf Stream west of Newfoundland, and calling the current off Western Europe the "Atlantic current," for which Dickson's name of "European current" is more descriptive and definite. The Atlantic is a large mass, and has a whole system of currents, of which the so-called Atlantic current is by no means the largest.

Drs. Helland-Hansen and Nansen, after rejecting the oceanic theory, accept as firmly established the dependence of variations in the earth's temperatures on the solar variations proved by sun spots, the numbers of solar prominences, and terrestrial magnetic disturbances. They point out that the influence of the sun on the weather of any area on the earth depends upon so complex a series of factors that the results at first sight appear inconsistent. The crude expectation that an increase of heat supply from the sun would raise the temperature of the whole earth was early dismissed, for the greater evaporation would lower the temperature on the coast lands by increased clouds, rain, and snow. Blanford pointed out, for example, the see-saw of oceanic and continental conditions; but, though his view has not been fully con-

firmed, his principle is supported by the proof that regions are oppositely affected by changes in the heat supply from the sun. Bigelow has divided the world into three groups of regions: In the "direct" group the temperature conditions vary directly with the sun; in the "indirect" group the variations agree in time, but are opposite in character; in the third, the "indifferent" group, there is no regular correspondence. Sir Norman and Dr. W. J. S. Lockyer have shown that a region may for years belong to the "direct" group, then suddenly become "indirect," and later return to the "direct" group. Drs. Helland-Hansen and Nansen accept this frequent inversion, and also their explanation of the phenomenon.

The author's instructive study of North Atlantic temperatures therefore strengthens the case for solar variations acting through the atmospheric circulation as the main cause of meteorological changes. To what extent the ocean helps by regulating the air temperature and circulation the authors do not discuss in the present memoir; that and other questions are to be dealt with after further investigations in a series of memoirs to which the present is introductory. The usefulness of the promised memoirs would be increased (should they have as many appendices and supplementary notes as the present) if each were provided with an index.

#### SERVICES OF A VESSEL-REPORTING STATION OF THE WEATHER BUREAU.

The following account of the grounding of the Dutch S. S. *Arakan* on August 29, 1920, near Point Reyes Light, Calif., has been furnished by Mr. J. C. Smith, in charge of the vessel-reporting station of the Weather Bureau at that place. It is published as an illustration of the services being rendered by the Bureau at vessel-reporting stations. The *Arakan* was subsequently refloated and arrived at San Francisco on September 1. The damage sustained, if any, is not known. The officers of the *Arakan* have for many years cooperated with the Bureau in marine work, and the news of her misfortune was received with regret.

On August 29, 1920, at 2 p. m. the Dutch S. S. *Arakan*, 5,000 gross tons, with cargo of sugar and rubber, bound from Batavia for San Francisco, went aground about 6 miles north of this station, during a dense fog. S. O. S. calls resulted in tugs being dispatched from San Francisco. However, they have not succeeded in pulling the vessel off. The vessel's wireless outfit failed on the 30th, and as a result this office was called upon for considerable information by maritime interests and newspapers of San Francisco. Weather and sea conditions were inquired about frequently; also, topographic conditions in the vicinity of the vessel. An aeroplane was dispatched from San Francisco to the scene of the wreck on the strength of information given by this office. Unless the vessel is pulled off the sand within a short time it may break amidship, resulting in the loss of the vessel as well as the valuable cargo.

This office remained open day and night during the critical stage answering inquiries by long-distance telephone.—F. G. T.

#### FIRST SCIENTIFIC CONFERENCE, PAN-PACIFIC UNION.

Under the auspices of the Pan-Pacific Union a scientific conference for the purpose of outlining a plan of exploring the Pacific Ocean was held at Honolulu, Hawaii, beginning August 2, and ending August 20, 1920. This conference brought together a few more than 100 scientists from the countries bordering on the Pacific Ocean. The United States, Australia, New Zealand, Japan, and the Philippine Islands were well represented.